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SMALL ARMS AIR DEFENSE TRAINING ON A REDUCED-SCALE RANGE.(U)
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The George Washington University
HUMAN RESOURCES RESEARCH OFFICE
operating under contract with
THE DEPARTMENT OF THE ARMY

The Human Resources Research Office is a nongovernmental agency of The George Washington University, operating under contract with the Department of the Army (DA 44-188-ARO-2). HumRRO's mission, outlined in AR 70-8 is to conduct research in the fields of training, motivation, and leadership.

(1)

(9) Consulting Report

(6) SMALL ARMS AIR DEFENSE TRAINING ON A REDUCED-SCALE RANGE,

by

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and
Robert J. Foskett

(12) 33 P.

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HumRRO Division No. 5
(Air Defense)

The George Washington University
HUMAN RESOURCES RESEARCH OFFICE
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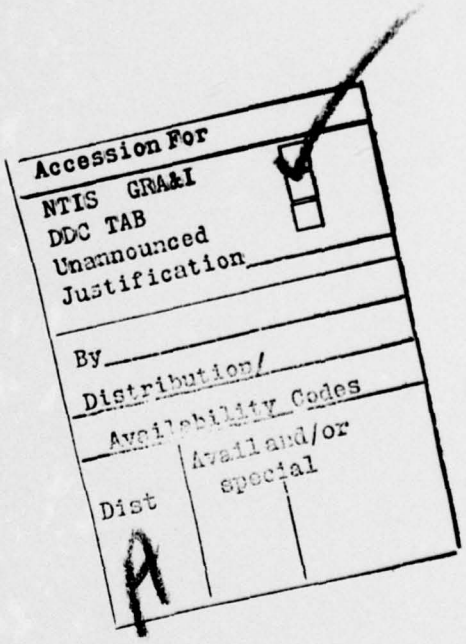
FOREWORD

This report presents the current status of a proposed program for training the use of infantry weapons in an air defense role. Conclusions from several studies and tests have resulted in the present recommendations for a scaled-down training environment.

Individuals from both HumRRO Division No. 5 (Air Defense) and the U.S. Army Infantry School have been actively concerned with this work. From HumRRO, suggestions and solutions to questions have come from Dr. Robert D. Baldwin, Mr. Walter E. Burrell, Mr. Richard C. Montgomery, and Sp/4 Stanley A. Sliko, Jr. The primary contributors to this recent work from the Infantry School are CPT Charles E. Newbern and 1LT Michael O. O'Neill. The work has been and will continue to be carried out at both Fort Bliss, Texas, and Fort Benning, Georgia.



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SMALL ARMS AIR DEFENSE TRAINING ON A REDUCED-SCALE RANGE

Requirement

At the request of the U.S. Army Infantry School, HumRRO conducted a study of the use of organic infantry weapons in an air defense role.[1] This study resulted in recommendations for an interim training program for the use of small arms in an air defense role.[2] A proposed program of instruction on "The Engagement of Aerial Targets" has been prepared by the U.S. Army Infantry School (USAIS) in Army Subject Schedule format and will be referenced in the revised FM 23-12. This program of instruction includes practical exercise on a miniaturized range and incorporates the range estimation and lead training demonstrated by HumRRO.[2]

The U.S. Army Infantry School has requested additional assistance in the development and testing of an adequate miniature range to be used for training the skills necessary to engage aerial targets. It will be necessary to train up to 200 men on this range during one training period. It was specified that, if at all possible, all aspects of the training program should be conducted on a miniaturized range.

This Consulting Report describes the necessary elements of a training program to be conducted in a scaled-down environment and the brief tests which are needed to evaluate a miniaturized range and to determine the length of training necessary to achieve minimal proficiency.

Assumptions and Conditions

The following information is the basis for the development of a training program in a scaled-down environment for the engagement of aerial targets by Infantry personnel:

1. Tactical Conditions.

a. Units will engage any aircraft committing a hostile act and helicopters or light aircraft positively identified as hostile, unless the commander has imposed passive air defense measures (concealment) to prevent disclosure of positions.

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[1] Letter, AJIIS-D, Hq, USAIS, dated 13 July 1965, Subject: Development of Techniques and Training Requirements for Use of Organic Infantry Weapons in an Air Defense Role.

[2] Interim Recommendations for a Small Arms Air Defense Training Program, Consulting Report, HumRRO Division No. 5 (Air Defense), Fort Bliss, Texas, December 1965.

b. The 7.62mm weapons are of primary interest at this time, although the skills for the 5.56mm and .50 caliber weapons could also be taught in a very similar, if not the same, scaled-down environment.

c. The effective range of the 7.62mm weapons against aerial targets is 350 meters.

d. The Changing Lead Technique of fire will be used against aircraft up to 200 knots, and the Pattern of Fire Technique will be used against aircraft at speeds over 200 knots.

2. Training Conditions

a. The training environment will be scaled down, retaining the essential physical relationships without altering the psychological relationships.

b. Anti-aircraft marksmanship training will be given after basic weapons qualification training.

c. All essential skills necessary for the engagement of aerial targets are to be taught in a scaled-down environment.

Approach

Engagement of aerial targets is a task that is composed of several component skills which have been identified in a psychological analysis of the complete task. The component skills will be taught in a scaled-down training environment in a step-wise manner, with the last phase combining all component skills of the task.

USCONARC wants information concerning the specifications and material for a tested miniature range. Therefore, the following program has been recommended in order to provide this information.

1. Design of a scaled-down range.

2. Construction of this range at Fort Benning, Georgia.

3. Training of a 20-man group on the scaled-down range.

4. Validation of the training program given on the scaled-down range by conducting live firing at towed aerial targets.

The time frame necessary to complete the above program is approximately four months, with the training and live firing programmed for 1 February 1967.

HumRRO will conduct several tests to determine the length of time necessary to develop proficiency in the component skills in addition to information to be used as guidelines for the training program.

Component Skills

As determined previously, the required skills necessary to successfully engage a moving aerial target with an infantry weapon are:

1. Range estimation.
2. Lead estimation.
3. Manual tracking.
4. Weapon operation.

It was determined that range estimation and lead tracking are the skills that should be stressed during training.

The Problem of Miniaturization

The following discussion considers a scaled-down range, which uses a moving aerial target range, having dimensions considerably less than those of the real world, but greater than those of a miniature or shooting gallery range. The range is an outdoor target facility for low muzzle velocity air rifles.

The concept underlying the use of a scaled range involves the reduction of the size of the real-world target situation for economy and space considerations. However, certain important aspects of aerial fire must be retained so that the firer will receive valid training with relationship to real-world parameters while firing in a reduced-world situation. The two most important parameters to be retained from the full-size target situation are the angular target velocity with respect to the firer and the number of target-lengths lead appropriate for each value of angular velocity.

The following target situation is assumed: An aircraft flying along a horizontal straight-line flight path past the firer. The projection of the flight path on the ground is at some value of crossing range from the firer's position. The plane flies at a constant velocity. It will be shown that for a given air rifle weapon there seems to be one size of scaled range that best represents the full-size angular velocity to target lead relationship.

1. A Basis for the Development of the Range.

a. The following mathematic analogy indicates an approach to the development of a scaled-down range. Any beginning algebra course includes a discussion of ratio and proportion based on the following relationship:

$$\frac{A_1}{A_2} = \frac{B_1}{B_2} \qquad A_1 = \frac{B_1}{B_2} A_2$$

The following definitions will be applied to the values in the equation above:

(1) B_1 = information concerning air rifle ballistics.
(2) B_2 = information concerning 7.62mm ballistics.
(3) A_2 = real-world linear dimensions.
(4) A_1 = scaled-down linear dimensions

b. The value of B_1/B_2 may be considered to be a scale factor that relates the scaled world to the real world. Corresponding items of information concerning air rifle and 7.62mm ballistics are compared below in order to arrive at a value for the scale factor, B_1/B_2. The first items to compare will be the muzzle velocities.

	Muzzle Velocity (Ft./Sec.)	Ratio (B_1/B_2)
BB Air Rifle	300	
7.62mm M-14	2,750	1/9.16

c. Assuming a scale factor of one-ninth, some ballistic properties are compared based on an air rifle to target range of 100 ft. and a 7.62mm range of 900 ft.

		BB	7.62mm	B_1/B_2
Slant Range to Target	(Feet)	100	900	1/9
Projectile Velocity at Target	(Ft./Sec.)	228	2125	1/9.33
Time of Flight	(Sec.)	.38	.37	1/1.03

The values of B_1/B_2 shown above show that the quantities involving a length such as feet and ft./sec. are scaled roughly by the same factor as the muzzle velocities, one-ninth, while the time of flight of the BB in the scaled world is within three percent of that of the 7.62mm round in the corresponding full-size situation. It may be shown that the angular velocity of the target on the scaled range will be the same as the

angular velocity of the full-size target. Since the projectile's time of flight is essentially the same in both target situations, the required lead expressed in target lengths, or as angle for that matter, will be the same in the two situations. It should be pointed out that the maximum ordinate of the trajectory does not scale by one-ninth, so that the air rifle requires more superelevation than does the 7.62mm weapon.

d. Example: Using a hypothetical target situation, the following numbers will result. A gunner fires at an aerial target at a slant range of 900 ft. (274 meters) with the proper lead to hit the target at its crossover point. The altitude need not be considered, but the target speed is 150 mph (102 ft./sec.). The target length is 45 ft. The bullet's time of flight is .37 sec., therefore, the lead is figured as follows:

$$\text{Linear Lead} = .37 \times 102 = 37.8 \text{ ft.}$$
$$= 37.8/45 = .84 \text{ Target Lengths}$$

At crossover the target would have an angular velocity of

$$w = \frac{v}{SR} = \frac{102}{900} = .113 \text{ radians/sec.}$$
$$= 6.5^{\circ}/\text{sec.}$$

Looking at the one-ninth scale situation, the following values are found:

Slant Range	100 ft.
Target Speed	16.7 mph (11.3 ft./sec.)
Target Length	5 ft.
BB Time of Flight	.38 sec.

Linear Lead = $.38 \times 11.3 = 4.3$ ft. = .86 Target Lengths

Angular Velocity $w = \frac{11.3}{100} = .113$ rad./sec. = 6.5°/sec.

e. The results indicate that the BB gun range gives the same values of angular velocity and required lead as the real situation. The BB gun ballistics will not be exactly one-ninth those of the 7.62mm throughout the weapon's entire useable range, but one-ninth is a realistic scale factor value for this particular weapon.

2. Can the Range Be Scaled Down Even Further?

a. A one-ninth scale range is still rather large, and a smaller range would be much more desirable from the standpoint of space and cost limitations. Retaining the same training weapon, a 300 ft./sec. muzzle velocity air gun, and using a new scale factor, one-twentieth, the following situation will result:

Slant Range	$\frac{900}{20}$ = 45 ft.
Target Speed	$\frac{150}{20}$ = 7.5 mph (5.1 ft./sec.)
Target Length	$\frac{45}{20}$ = 2.25 ft.

BB Time of Flight (45 ft.) .16 sec.
Linear Lead = .16 x 5.1 = .816 = .363 Target Lengths
Angular Velocity = $\frac{5.1}{45}$ = .113 = 6.5°/sec.

b. The angular velocity of the scaled target is the same as that for the full-size target and will always be the same, no matter what the scale factor, but now a .363 length lead is required instead of the .84 length lead required to hit the real aircraft.

The above discussion means that to realistically train people to get a feel for the proper magnitude of lead required for a given velocity target, a target range scaled to the ballistics of the appropriate weapon must be used. People can be trained to lead a target by .84 lengths on a one-twentieth scale range, but the target's angular velocity will have to be greater than the 6.5°/sec. value in the full-size situation. In order to train people realistically on a small range with a scale factor less than one-ninth, a training weapon with a muzzle velocity less than 300 ft./sec. will be needed. This is about the lowest muzzle velocity that is available in a commercially-made air rifle.

After looking at the problem a while, it may be decided to ignore the angular velocity and the training weapon ballistic relationship. Instead, a one-fiftieth scale might be selected and a 575 ft./sec. muzzle velocity, semi-automatic, carbon dioxide pellet rifle might be used to give a small range size and a more accurate weapon. Target speeds could be calculated for the pellet rifle's ballistics so that one, two, or any number of target lengths lead would be required, but it should not be thought that the target's speed or angular velocity with respect to the tracker-firer bears a realistic relationship to the real-world situation.

A solution to the problem is to pick an ideal weapon that realistically simulates the most important characteristics of standard service weapons and then to build an aerial target range scaled such that the projectile's time of flight to various distances will be the same as to the corresponding full-size distance. The following section contains a discussion of some low-velocity weapons that might be considered for training weapons.

Selection of a Sub-Caliber Weapon

The training weapon chosen for a scaled-down aerial target range should look, feel, fire, and smell like a real service weapon with greatly decreased, but similar, ballistics and be relatively inexpensive to procure and fire. Such a weapon does not exist, but various types of air rifles do have some of these features. Listed below are several desirable features that should be incorporated into a training weapon.

1. Semi-Automatic Operation. Due to the dynamic target and threat imposed by low-flying aircraft, it is rather ridiculous to assume that a single-shot air rifle would be a realistic weapon choice. The firer would want as many chances as possible to "bring down" the target while it is in range. The Pattern of Fire concept, when used by small groups of firers, is difficult to apply if single shot weapons are to be considered. With a rapidly cocked weapon it is hardly likely that more than a couple of shots will be fired on any one pass. A few air rifles presently on the market feature semi-automatic operation.

2. Type of Mechanism. At the present time there are only three types of air rifles on the market; the spring air rifle, the pneumatic air rifle, and the carbon dioxide rifle. The only weapons that allow semi-automatic operation are certain carbon dioxide rifles. The other weapons require some type of cocking or pumping action between shots. The spring-type weapons have a certain amount of recoil before the round leaves the muzzle, resulting in some inaccuracies if the weapon is not held firmly.

The carbon dioxide weapons require small steel cylinders of carbon dioxide gas under pressure. Each cylinder is only good for 30-80 shots before the pressure falls off. The expense and supply problems involved in using carbon dioxide cylinders makes them rather a nuisance. One alternative solution to this problem might be to have each gun on the firing line supplied with compressed air from a flexible hose attached to a fitting on the bottom of the stock. The hoses would be connected to a common air supply fed by a standard air compressor. With this system the air pressure would power the semi-automatic operation and should give a fairly constant muzzle velocity. A flexible hose hanging under the stock should not interfere much with the operation of the weapon.

3. Muzzle Velocity. If muzzle velocity is representative of a weapon's exterior ballistics, then a low value of muzzle velocity would be preferable, say 300 ft./sec. or less. Most of the cheaper spring-type air rifles have velocities of 300-350 ft./sec. The muzzle velocities of carbon dioxide weapons vary from 375 to around 600 ft./sec. and are greatly affected by the remaining pressure in the carbon dioxide cylinder. The ballistic data (firing table) for the spring-type BB gun is contained in Table 1.

Table 1

Ballistic Data - Air Rifle*

300 Ft./Sec. Muzzle Velocity											
	0	10	20	30	40	50	60	70	80	90	100
Velocity (Ft./Sec.)	300	294	286	280	270	263	255	246	240	233	228
Ordinate (Feet)	0	.2	.35	.48	.56	.59	.58	.52	.4	.23	0
Time of Flight (Sec.)	0	.035	.07	.11	.14	.18	.22	.255	.295	.34	.38
400 Ft./Sec. Muzzle Velocity											
	0	10	20	30	40	50	60	70	80	90	100
Velocity (Ft./Sec.)	400	390	380	370	360	350	340	330	320	312	304
Ordinate (Feet)	0	.115	.201	.28	.32	.33	.315	.285	.225	.14	0
Time of Flight (Sec.)	0	.025	.05	.075	.105	.135	.16	.19	.23	.25	.29

* This data was provided by the U.S. Army Ballistic Research Laboratories.

4. Pellets vs. BB's. Both types of ammunition have their advantages and disadvantages. Costwise, both are bargains, with BB's the cheapest (10,000 for $3.04). The pellet is probably ballistically more realistic than the BB; whereas the BB is usually much easier and faster to load into the weapon than the pellet, which must usually be loaded individually and oriented in a given direction so that it feeds correctly. No matter which type of ammunition is used, it should probably be spring-fed rather than gravity-fed so that a shot is assured each time the trigger is pulled. A pellet rifle usually has a rifled barrel which gives more accurate fire than the unrifled BB gun.

5. Sights. Even if a weapon does not feel and smell exactly like the real thing, it should have the same sight picture as a real service weapon, especially if some sort of opening range estimation is to be made using the front sight.

6. Recoil. It may be important to simulate the recoil that is involved in firing a real weapon. Recoil from successive shots plays an important part in tracking a moving target, and it might be an advantage to simulate its effects also.

Description of Training Program and Scaled-Down Range

1. Program Procedure. The training program has been broken down into discrete steps to assure attainment of proficiency on each component skill as follows:

a. A lecture period during which the entire task of engaging moving aerial targets is discussed.

b. Range estimation instruction and practice.

c. Lead estimation instruction and practice.

d. Lead estimation and tracking practice with familiarization firing of a sub-caliber weapon.

e. Engagement of moving aerial target, which combines all component skills.

f. Critique of firing results.

g. Review of aircraft recognition training.

The above seven steps will be accomplished on a reduced-scale range, represented in the block diagram (see Figure 1).

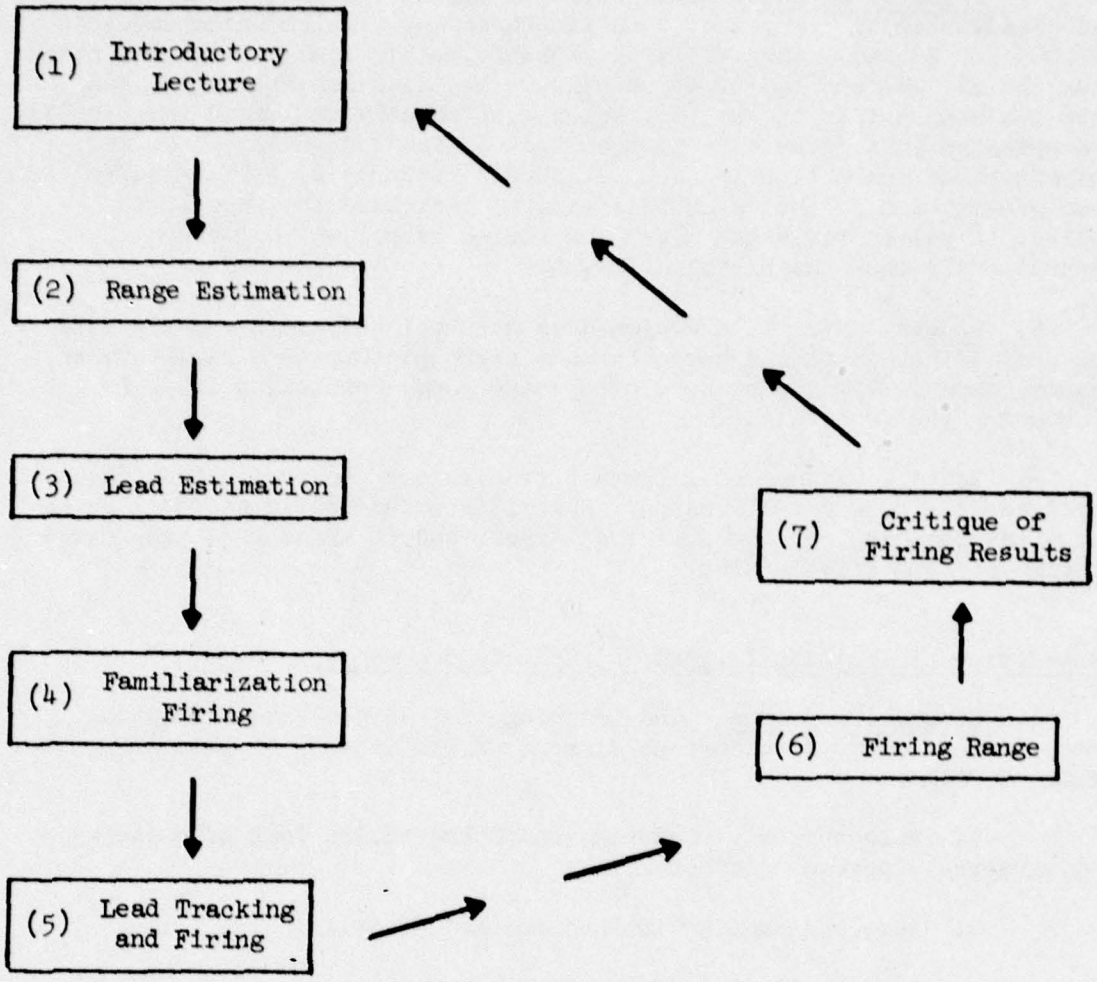


Figure 1

Block Diagram of Training Program

2. Range Estimation Training. During the initial instruction period it will be pointed out that to make maximum use of ammunition, the target should be fired upon only while it is within the effective range of the weapon (350 meters for 7.62mm weapons). This determination requires the gunner to estimate the range of the target. Simple rules will be provided to assist the trainee in estimating range.

At Station No. 2 in the block diagram, the trainees will practice using the rules for estimating 350 meters. Both the rifle sight and index finger (which may be more appropriate for use by machine gunners) methods of estimating range will be taught. Figure A-1 of Appendix A illustrates the correct relationship between the range estimation aid and the target at a range of 350 meters. The target will consist of a representative aircraft scaled to approximately 1/72 of actual size. The training device will be so constructed that the instructor can move the target "in" and "out", stopping it when the trainee indicates it is at the correct range (see Figure A-2, Appendix A).

Each trainee will use a service rifle during the training trials employing the rifle sight.

The number of trials necessary for the trainee to learn the correct relationship between the target and the range estimation aid (either rifle sight or index finger) will be determined by HumRRO in a series of tests to be conducted at Fort Bliss, Texas.

3. Lead Estimation Training. In order to hit a moving aerial target, the rifleman must determine the correct aim point somewhere in front of the aircraft. It is a difficult task to locate this aim point in space with the few reference points that are available in the sky. The aircraft itself is the best reference available, and the apparent aircraft length is the best reference scale available.

Because of the dynamic nature of the geometric relationships characteristic of anti-aircraft firing, the correct lead changes continuously. However, the training problem can be reduced by teaching two or three different leads which are appropriate for a wide range of aircraft speeds (up to 200 knots), crossing ranges (out to 300 meters), and altitudes (up to 300 feet). When target speed exceeds 200 knots, the Pattern of Fire Technique must be used. Both the Changing Lead and Pattern of Fire Techniques will be explained during training, in addition to the lead estimation practice.

The concept of lead will be explained during the initial period of instruction. At Station No. 3 in the block diagram, the trainees will receive practice in estimating various leads using the apparent aircraft length as a scale. Scaled-down two-dimensional aircraft diagrams will be

used as targets. The trainee will be told to estimate a lead in aircraft lengths, which he will do by positioning his weapon so that it points at what he estimates to be the correct aim point. (The weapon will be placed in a cradle-like holder pivoted beneath the rifle butt.) An aircraft silhouette will be raised by the instructor to indicate the correct lead point. The trainee will thus be able to immediately check his estimate. Figure A-3 of Appendix A is an illustration of this device.

4. Familiarization Firing. Prior to firing at the moving target on the scaled-down range the trainee should have familiarization firing with the sub-caliber weapon to be used. (The most readily available sub-caliber weapon is a BB gun with a muzzle velocity around 300 ft./sec. Figure A-4 of Appendix A shows a sample training weapon with and without the M-14 sight.) At Station No. 4 the trainee will be given an opportunity to become familiar with the operation of the training weapon before he is required to fire at a moving target. A half-man silhouette will be used as a target, constructed of a material that will provide auditory feedback concerning hits.

5. Lead Tracking and Firing. After the trainee has become familiar with the training weapon, he will move into the next training step, which combines lead estimation and tracking with weapon operation. At Station No. 5 the trainee will lead and fire at a slow-moving target.

A model or two-dimensional cut-out of an aircraft will be suspended from a sloping line and weighted so that it moves down the line. The correct aim point will be marked for various aircraft length leads similar to Figure A-5 in Appendix A. The trainee will be required to aim at, track, and fire at the moving aim point, while keeping the target in view. The relationships of speed, distance, and size will be such that a correctly aimed shot would hit the target and the sound of the hit could be heard by the trainee.

During this training exercise a "coach-pupil" arrangement should be used to insure that the trainee (pupil) aims correctly and continuously tracks the aim point while firing.

6. Firing on the Scaled-Down Range. Each trainee will be required to combine the component skills he has learned into the task of engaging moving aerial targets on the scaled-down firing range. Again, a coach-pupil training arrangement will be used. Each trainee will fire a specified number of rounds, which will be determined by HumRRO, during practice and then fire for record. Practice and record firing will be accomplished in groups of five trainees, which will be necessary in order to later train up to 200 men during one training period. Firing results will be recorded as team scores.

The scaled-down firing range will consist of a quarter-mile oval track with two straight sides of approximately 100 meters each. The curves will be banked for a motor vehicle traveling up to 30-35 mph. Two to four firing lines, with five positions each, could be located around the inside of the track, with firing distances altered as necessary.

At the present time it does not appear that the use of three-dimensional targets will be necessary for training; therefore, two-dimensional printed targets will be used, scaled to one-tenth actual size, four to five feet in length.

Methods of moving the target have been studied at length, with the initial conclusion being that a target-holding device be fitted into the rear of a jeep (see Figure A-6, Appendix A). This device could be held in place by sandbags and would carry the target 10-15 feet above the jeep. The holding device would be so constructed to facilitate quick and easy change of targets. The jeep could be protected from possible damage by the BB ammunition with a shield of plywood or target cloth.

Validation of Reduced-Scale Range

The concept of miniaturized training for small arms air defense has yet to be validated; that is, it is not known to what degree training in the miniature environment will transfer to the operational task of firing at moving aerial targets with small arms. Therefore, the proposed training program must be tested by having personnel trained on the reduced-scale range fire at towed aerial targets using service weapons.

Live Firing Test. It is proposed that as soon as the range is constructed a group of AIT personnel be given the training program. The next day, using the M-14 rifle, the trainees would fire at a towed aerial target. Training scores will be compared with the live firing scores to evaluate the transfer of training.

A second group (control group) will also fire at the towed target and will receive brief verbal instructions concerning the engagement of moving aerial targets just prior to firing. The live firing scores for the training group will be compared to the scores for the control group in order to evaluate the effectiveness of the training program. These scores will also be compared with live firing results from previous field tests for further evaluation of the training program.

The targets to be used for the live firing tests will be towed sleeve-type targets. The Infantry School will determine whether or not the Army aircraft U-6A can be modified in time for the test to tow the targets. If this modification cannot be accomplished, the Navy should be

requested to provide tow support for the firing test. The proposed Test Design Concept is discussed in Appendix B.

Preliminary Tests to be Conducted by HumRRO

Before a complete training program can be prepared, several tests must be conducted. These tests will primarily provide information necessary to determine the number of training trials required for a group of trainees to reach a specified proficiency level for each of the component skills composing the task of engaging a moving aerial target.

1. Range Estimation. The training environment will be scaled down to 1/72 of the actual size. The instruction will concentrate on the trainee learning the relationship between the target aircraft and the training aids at a range of 350 meters.

HumRRO will conduct a study to determine the number of training trials required for Army trainees to reach the specified criterion. The criterion established on the basis of previous tests will be no more than a 10% error of estimation for 90% of the trainees.

2. Lead Estimation Training. Using as a target a two-dimensional figure of an aircraft reduced in size to one foot in length, the trainees will be taught to use the apparent aircraft length to estimate various leads. The minimum number of training trials to acquire this skill will be determined in a preliminary study at Fort Bliss.

3. Lead Tracking and Firing. Once the trainee has learned to correctly estimate lead in a static situation, he must then transfer this skill to a moving target situation. During this training step, the trainee will fire the training weapon at a slowly moving target. The aim point for firing will be two apparent aircraft lengths in front of the target, designated by a wire silhouette of an aircraft. The relationship will be such that a hit on the target will be obtained if the trainee aims correctly and continuously tracks the aim point.

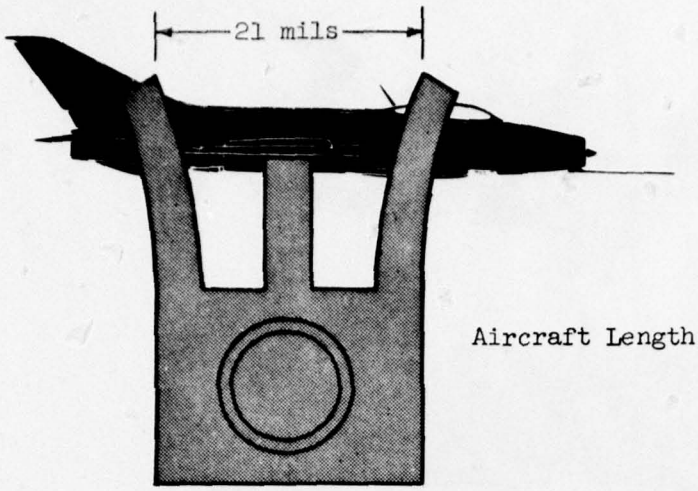
Both the training criterion and number of training trials required to reach this criterion will be determined in a study at Fort Bliss.

4. Firing on the Scaled-Down Range. The final step of training will require teams of trainees to combine all skills making up the task of engaging a moving aerial target. Teams that fail to demonstrate the specified proficiency level should be recycled through the training program. This desired level of proficiency and the number of practice rounds needed by the trainees to achieve this level will be determined in preliminary firing tests at Fort Bliss.

APPENDICES

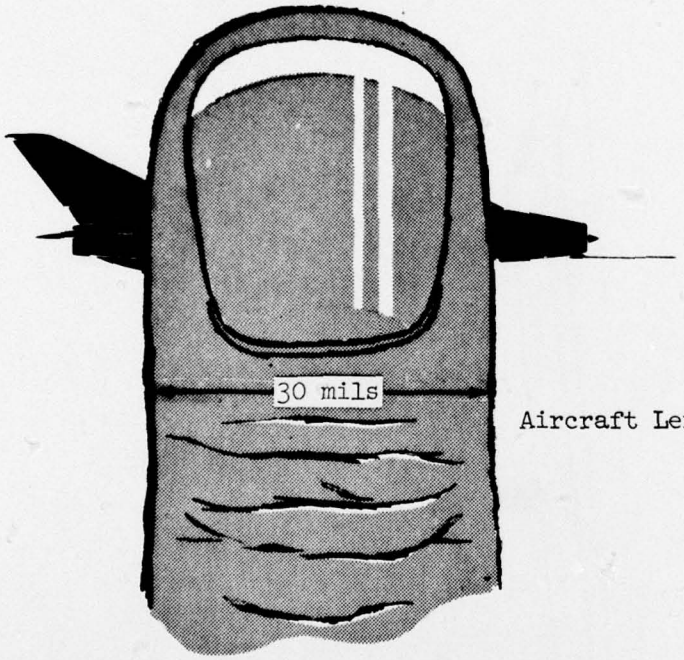
APPENDIX A

Diagrams of Training Devices



Aircraft Length - 13 Meters

FRONT SIGHT PICTURE OF RUSSIAN
Mig 21 AT 350 METERS.



Aircraft Length - 13 Meters

INDEX FINGER - TARGET RELATIONSHIP
(Index Finger Held at Arms Length.
Target at 350 Meters.)

Figure A-1

Range Estimation Aids

1/72 Scale Model Pulled Along in Wooden Channel by Coach.
The Side of the Channel Has Range Markings.
The 350' Mark Would be About 16' From
The Firer's Eye.

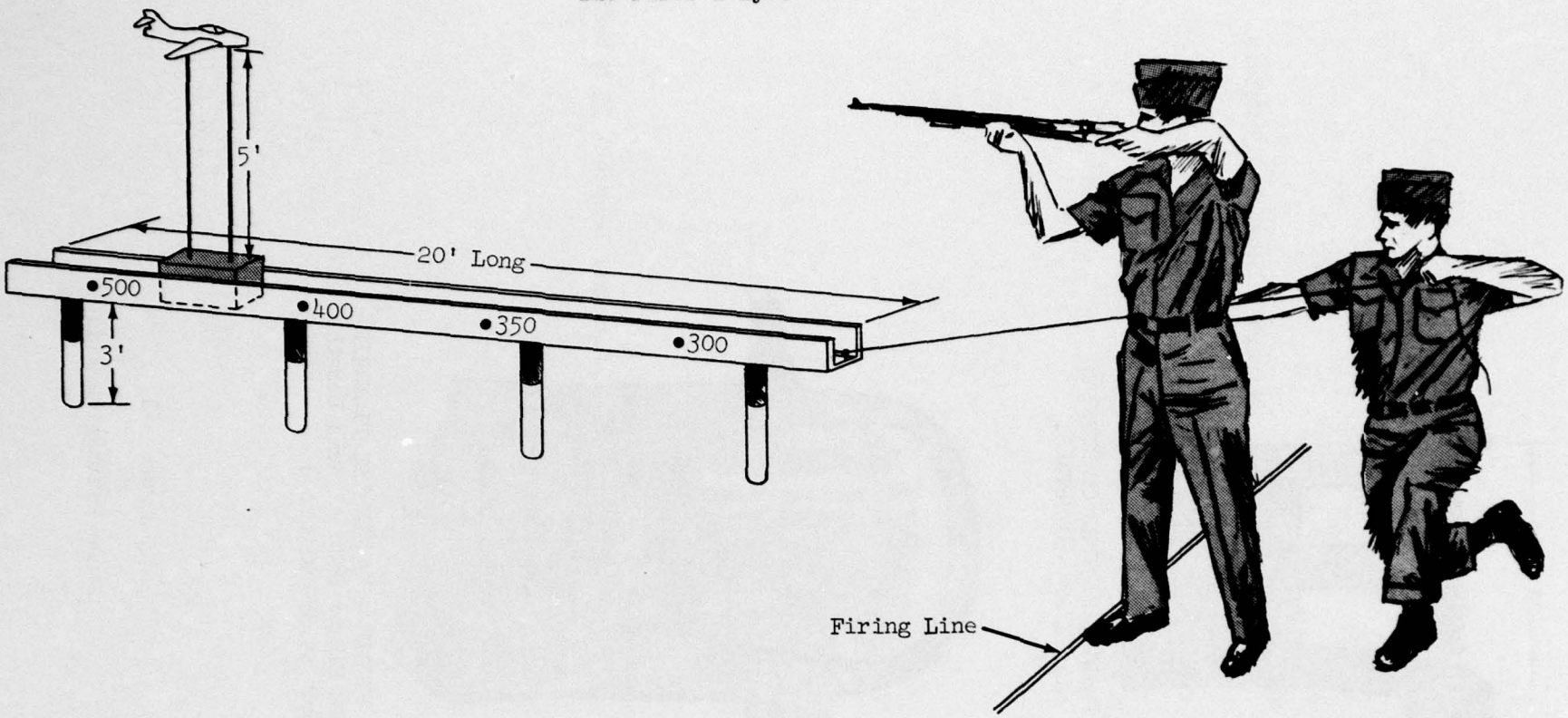


Figure A-2

Range Estimation Training Device

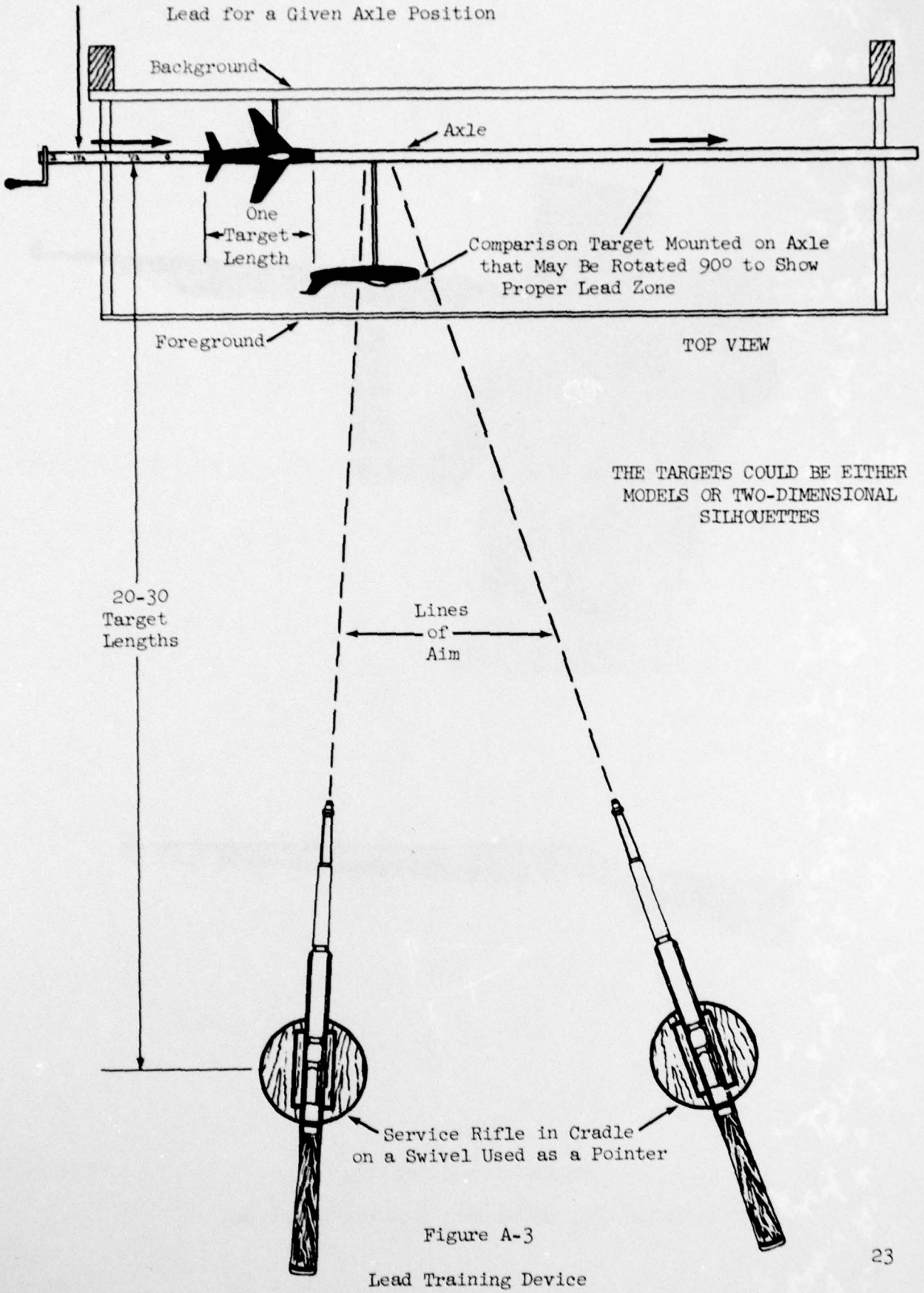


Figure A-3

Lead Training Device

Figure A-4

Photos of Training Weapon

BB Gun With and Without M-14 Sight Attached

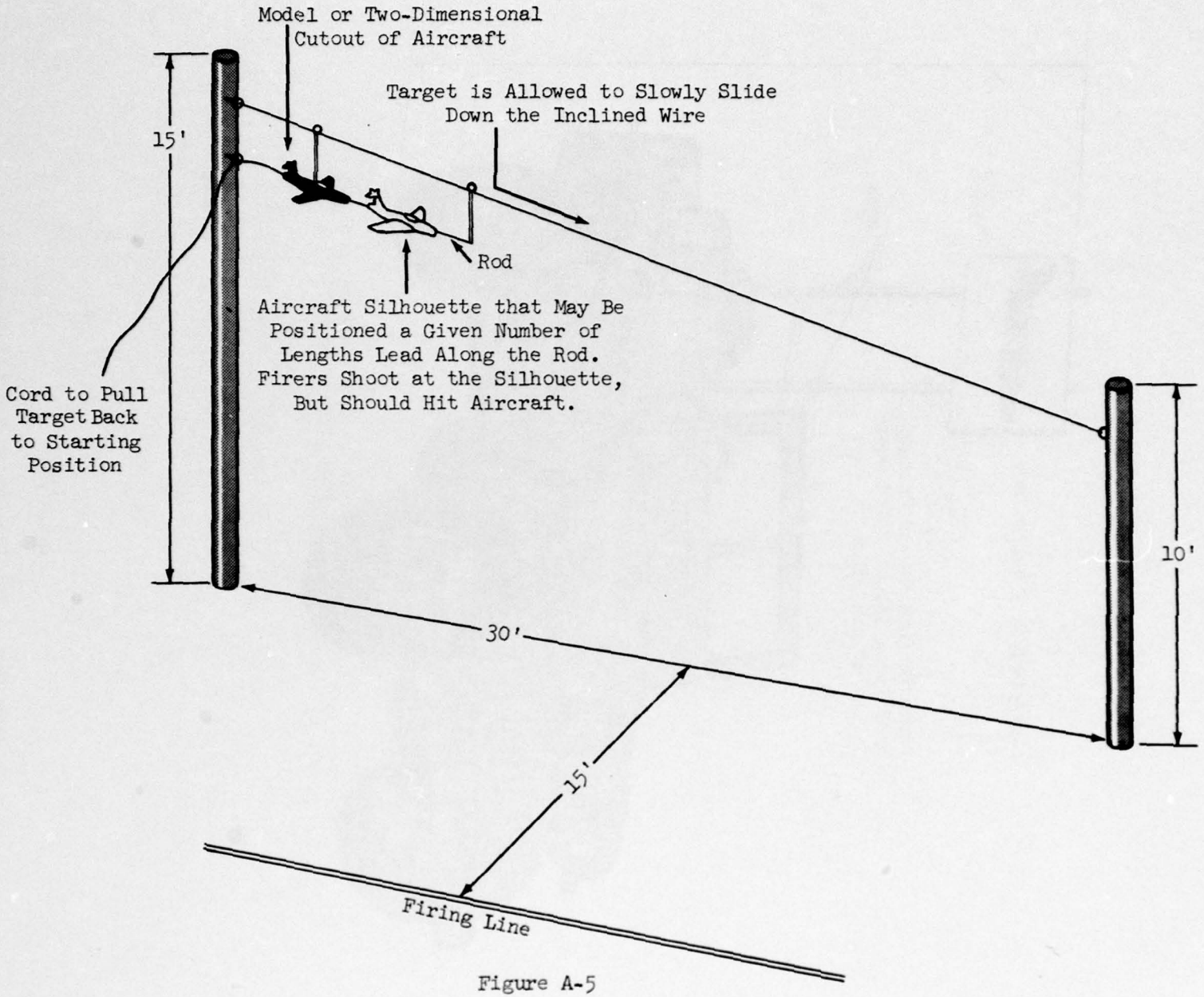


Figure A-5

Lead Tracking and Firing Device

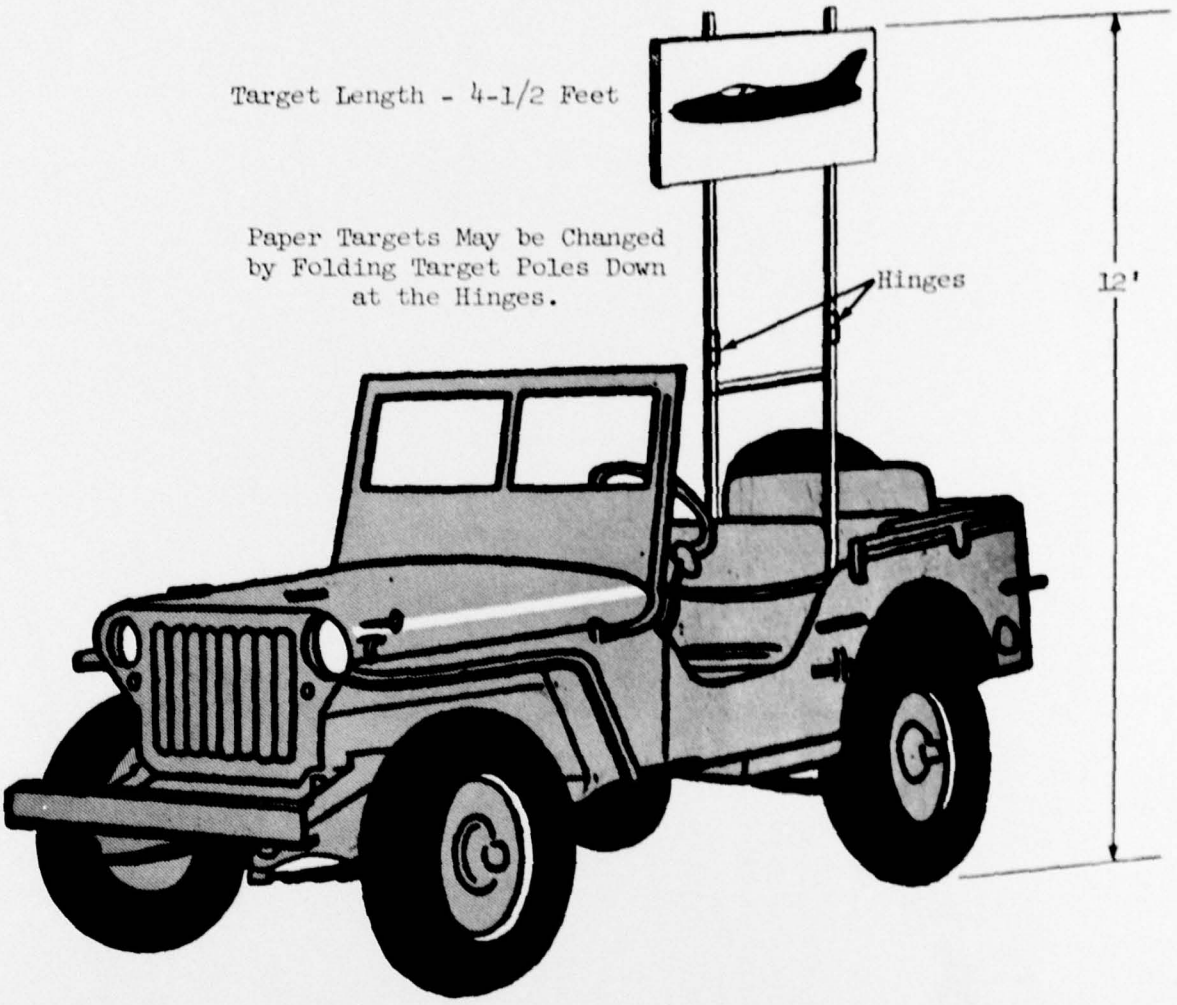


Figure A-6

Moving Target Holding Device Mounted on Jeep

APPENDIX B

Test Design Concept for Live Firing Validation of Reduced-Scale Training Program

Appendix B

TEST DESIGN CONCEPT FOR LIVE FIRING VALIDATION OF REDUCED-SCALE TRAINING PROGRAM

Subjects

Forty AIT or BIT personnel that have qualified with the M-14 rifle will be needed, with qualification scores representative of the range of scores above qualification. Personnel should have 20/20 vision, corrected.

Trainees will be randomly divided into two groups: An experimental training group and a control group.

Experimental Procedure

The training group will receive instruction and practice concerning the component skills of the task of engagement of moving aerial targets using the M-14 rifle. This training program will be conducted on the prototype scaled-down air defense training range.

At the end of training, the trainees will fire for record at the scaled-down moving aerial target. Scores will be determined for teams of five men firing at the same time. Each trainee will fire 100 rounds of BB ammunition.

The training program will be conducted by USAIS personnel with assistance from HumRRO personnel.

Live Firing Test

The live firing test will be conducted on the same range that the training program was administered on the day following training.

Five-man teams from each group will be randomly assigned to firing orders. Each man will fire 100 rounds of ball ammunition with the M-14 rifle. An aerial target will be towed past the firing line several times for each firing order. After each order has fired, the target will be dropped and the hits counted. Scoring will be accomplished by a scaling factor which indicates the relative size of the towed target compared with an appropriate aircraft of actual size. Scores will be recorded as percentage of hits obtained for rounds fired.

The target will be towed at approximately 150 knots at a crossing range of 100-200 meters and at altitudes between 100 and 200 feet. A total of eight orders will fire, requiring eight sleeve targets.

Each of 40 men will fire 100 rounds of 7.62 ball ammunition, requiring a minimum of 4000 rounds of ammunition.

Statistical Analyses

A chi-square analysis will be used to compare the performance of the training group with that of the control group. The total number of hits will be counted and compared with the total number fired.

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

At the request of the U.S. Army Infantry School, HumRRO conducted a study of the use of organic infantry weapons in an air defense role. This study resulted in recommendations for an interim training program for the use of small arms in an air defense role. This program of instruction includes practical exercise on a miniaturized range and incorporates the range estimation and lead training demonstrated by HumRRO.

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